LA-UR -82-1425

Conf-820609--31

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.

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TITLE: METALLOGRAPH FOR THE EXAMINATION OF LOW-LEVEL RADIOACTIVE SAMPLES

AUTHOR(S): J. H. Cook, CMB-14
D. S. Shaffe[illegible]MB-14
W. F. Pett[illegible] [illegible]lty Optical Systems, Inc.

SUBMITTED TO: ANS Summer Meeting in Los Angeles, CA, June 7-11, 1982

LA-UR--82-1425

DE82 015729

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

FORM NO 836 R4
ST NO 2629 5/81

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METALLOGRAPH FOR THE EXAMINATION OF LOW-LEVEL RADIOACTIVE SAMPLES

J. H. Cook, Los Alamos National Laboratory
CMB-14, MS G742
P. O. Box 1663
Los Alamos, N.M. 87545
(505)667-4653

D. S. Shaffer, Los Alamos National Laboratory
CMB-14, MS G742
P. O. Box 1663
Los Alamos, N.M. 87545
(505)667-4653

W. F. Petty, Specialty Optical Systems, Inc.
10210 Forest Lane
Dallas, TX 75243
(214)340-8574

ABSTRACT

Los Alamos National Laboratory and Carl Zeiss, Inc. have built a new remote-controlled metallograph for use in a low-level radiation background. The metallograph is low cost compared to a conventional remote-controlled metallograph. The motors that drive the stage motions and focus are commercially available and attach to the metallograph without modification. The metallograph was installed on a drawer in a blister behind a shielding door. This allows the metallograph to be reached quickly and easily for maintenance and repair.

INTRODUCTION

Los Alamos National Laboratory Group CMB-14 operates hot cells used for examination of irradiated fuel pins and other radioactive samples. Our hot cell facility consists of two blocks of hot cells, with each block having eight cells. Each block is separated by a corridor with four cells on each side, and each block has a "blister" that houses a shielded, remote metallograph. This paper describes a new remote-controlled metallograph installed by Group CMB-14 to replace a 20-year-old model located in one of the blisters. The new metallograph is low cost compared to a conventional remote-controlled model and unique design features make it easily accessible for maintenance.

DESCRIPTION

Because of the unsatisfactory performance of the old metallograph in the blister designed for the examination of beta-gamma radioactive samples, we began to look for a replacement. Our first proposal was to replace the metallograph with a commercially available remote-controlled model like those used for plutonium samples, however, the cost was prohibitive. We discussed these problems with a Carl Zeiss Optical Equipment dealer who suggested the possibility of modifying a new model Carl Zeiss metallograph for remote control.

DESIGN CRITERIA

We established the following criteria for the metallograph and the blister.

(1) A highly efficient optical system coupled to a stable, compact platform.

(2) The components to be commercial items adapted to the system in the most cost-effective manner.

(3) Radiation-hardened optics were highly desirable.

(4) The metallograph must be compatible with the blister with minimum modification.

(5) The metallograph must be easily accessible and removable from the blister.

DESCRIPTION OF THE METALLOGRAPH

We concluded that the best possibility for achieving the design criteria was to use the Carl Zeiss IM35 as the basic unit. Figure 1 shows the unit, an inverted microscope that has a stable optical platform and that will accept most Carl Zeiss optical components. It has a fixed stage and is focused by movement of the nose piece section. We believed that the camera port, located on the front face of the metallograph at right angle to the optical axis of the objectives, could be coupled to an optical tube long enough to extend through the shielding of the blister for observation and photography.

The camera system is a standard Carl Zeiss MC63 automatic camera with 4- by 5-in. film format. The illumination system is a standard 75-W xenon arc lamp mounted in a standard Carl Zeiss lamp housing.

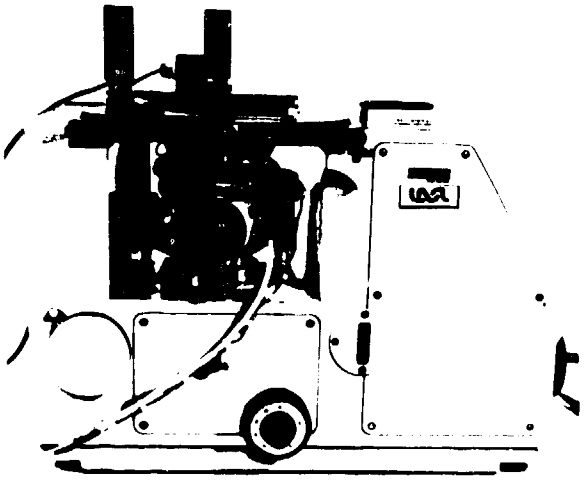

Fig. 1. Carl Zeiss IM35 Metallograph.

The system is compact and highly stable with high-performance Carl Zeiss Epiplan Pol objectives. The metallograph can do interference contrast, polarized light investigations and standard bright-field observations.

The motor that drives the focusing mechanism is a commercial Carl Zeiss component that is attached directly, without modification, to the coaxial focusing knob of the metallograph. The motors that drive the X-Y motions of the stage and rotate the stage are also attached without modification. The control units for the various servo motor drive systems came from the Carl Zeiss Axiomat program.

Carl Zeiss provided the basic IM35 metallograph and designed and built an optical tube long enough to allow viewing and photography outside the blister shielding. The optical tube (Fig. 2) is threaded and can be removed by simply unscrewing it from the metallograph. The motors that drive the stage in the X and Y directions are operated by a control unit outside the shielding, and the stage is rotated by a motor and drive wheel. Because the drive motors for the X-Y directions and the electrical wires to these motors rotate with the stage, stage rotation is limited to about 180° either way from the initial operating position. The stage with the X-Y drive motors and rotation motor is shown in Fig. 3. The motor for the focusing drive is also operated by a control unit identical to that used to operate the X-Y motion motors of the stage. Each control unit has a joystick that controls the motion of two motors. For example, the two motors that provide X-Y motions for the stage are controlled from one control unit. A second unit controls motors for the stage rotation and focus drive.

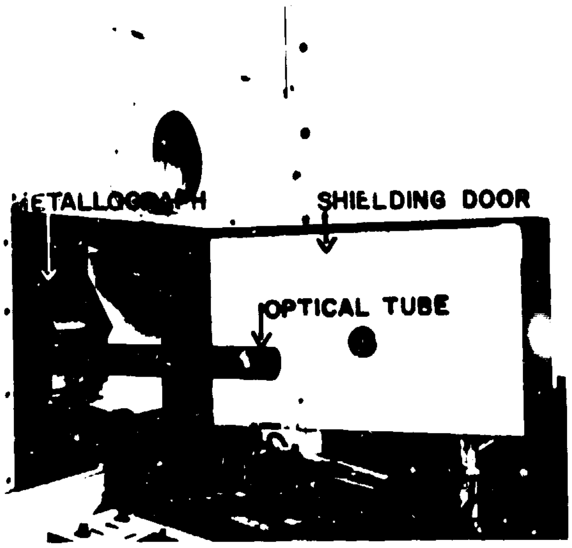

Fig. 2. Optical tube and front face of the metallograph in the blister.

The capability to remotely select different objectives for viewing, designed and built at Los Alamos, was achieved by placing a gear around the outside of the objective turret. A motor and gear were placed so as to engage the turret gear. The motor rotates the turret and objectives into position for viewing. A microswitch engages stops located on the gear. As each objective comes into position for viewing, the microswitch automatically opens the circuit to the drive motor. Thus, as each objective is positioned for

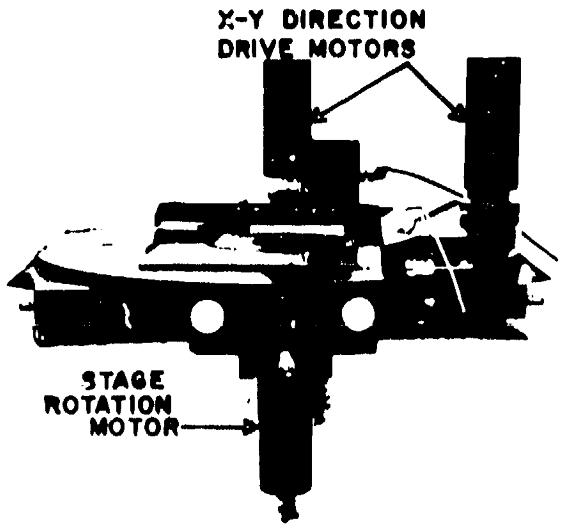

Fig. 3. Stage for the metallograph with X-Y and rotation drive motors.

viewing, the drive motor stops. An encoder was also placed on the metallograph and a ring with different slots was placed on the gear to correspond with the objectives. The objectives are numbered, and the encoder detects the number of the objective in place for viewing. This number is displayed near the metallograph controls so that the operator knows which objective is positioned for viewing. The objective turret is shown in Fig. 4.

Cables are attached to the apertures of the metallograph for remote adjustment. A cable was attached to the rotatable analyzer for remote control of the polarized-light capability. The cable allows the operator to insert or retract the analyzer and rotates it for adjustment.

BLISTER MODIFICATION

A shielding door (shown in Fig. 2) was built into the blister to allow convenient access and for easy removal and replacement of the metallograph. The door was fabricated from depleted uranium for maximum shielding and a hole was machined into the door to accommodate the optical tube.

The metallograph was placed on a drawer for easy withdrawal from the blister. A jack on the drawer lowers the metallograph for removal and raises it after it is returned to the blister. The jack also provides easy height adjustment. This arrangement is shown in Fig. 5. The controls and electrical wiring for the metallograph were built into the drawer so that a minimum of disassembly is required for removing the metallograph from the blister. The metallograph and operating control are shown in Fig. 6.

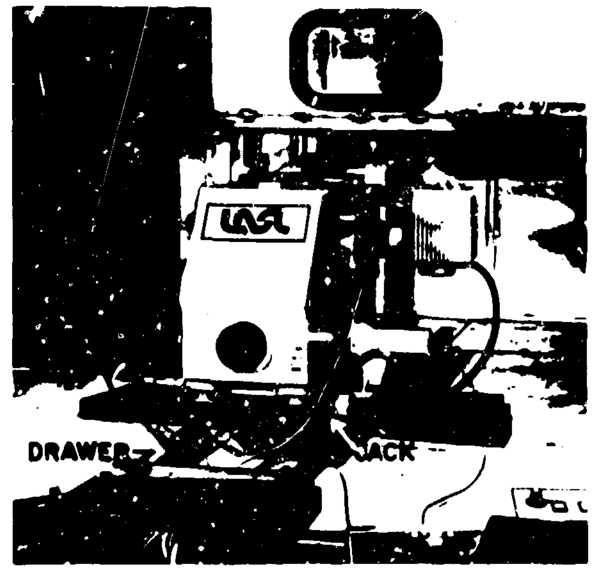

Fig. 5. Metallograph in place on the jack and drawer.

We were unsuccessful in obtaining nonbrowning optics in the metallograph. Although this is a significant limitation in examination of highly radioactive samples, the standard optics can be replaced several times for about the same cost as nonbrowning optics.

Two identical metallographs were purchased and one was placed in the blister. The second unit was purchased as a backup and for use in the metallography laboratory. This second metallograph has been in operation for more than 2 years.

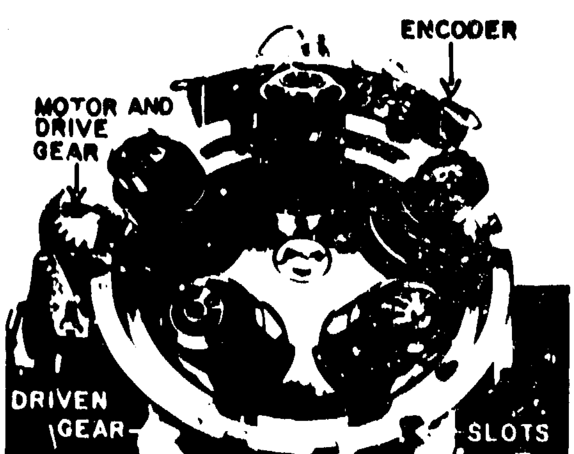

Fig. 4. Objective turret as modified for remote use in the blister.

Fig. 6 Operating control for the metallograph.

DISCUSSION

A low-cost, high-performance system can be obtained with other optical systems. The basic requirements are:

(1) Inverted optical system.

(2) Fixed stage with focusing nosepiece.

(3) Optical path access at righ angle to the objective optical axis, preferably a camera access port.

All systems will require various degrees of custom modifications, but none of these modifications is cost prohibitive.

Initial cost savings of this system over traditional systems can be from $100,000 to $200,000. Reduced maintenance costs (in-low-level examinations) will contribute additional savings over the life of the instruments.

ACKNOWLEDGEMENTS

We gratefully acknowledge the engineering and design contributions of W. A. Stone, P. F. Stibbard, L. A. Dominguez, and J. L. Riley of the Los Alamos National Laboratory.